Claims

What is claimed is:

1. A superconducting permanent magnet apparatus, comprising

(1) a composite bulk which is composed of one or more bulk superconductor(s) that are held in a vacuum vessel in a thermally insulated condition, and that become magnets by capturing a magnetic field in a superconductive condition,

(2) at least one pair of said vacuum vessels that are positioned at such a distance that the magnetic field generated from said composite bulks in each of said vacuum vessels affects each other, thus making a composite magnetic field,

(3) a vacuumizing apparatus for vacuumizing said vacuum vessel,

(4) a cooling apparatus for cooling said bulk superconductors below the superconductivity transition temperature so that said bulk superconductors are in superconductive condition,

(5) a magnetizing coil generating a magnetic field for magnetizing said bulk superconductors, said magnetizing coil either being a superconductor coil, or being a cupper coil generating a pulse magnetic field,

(6) wherein, each of said composite bulks is composed of a plurality of said bulk superconductors being arranged substantially in parallel with each other.

2. A superconducting permanent magnet apparatus described in Claim 1, wherein, each of said composite bulks is constituted such that a plurality of said bulk superconductors are arranged substantially in parallel with each other, wherein the magnetic pole planes thereof are placed along a curved plane that forms a part of the surface of a cylinder or of a sphere.

3. A superconducting permanent magnet apparatus described either in Claim 1, or in

Claim 2, wherein, each of a plurality of said bulk superconductors constituting a composite bulk, which are arranged substantially in parallel with each other, (i) is of the form of cylindrical column, or, of rectangular column, (ii) has a plurality of crystals of which c-axis is substantially aligned in the longitudinal direction of said column, and further (iii) is placed close to each other.

4. A superconducting permanent magnet apparatus described either in any of Claims 1–3, wherein, said composite bulk is held, inside said vacuum vessel, with a heat insulating, structural members that are made of resin-based materials.

5. A superconducting permanent magnet apparatus described either in any of Claims 1–3, wherein, said cooling apparatus is constituted such that said composite bulk is thermally contacted with a cooling part of a freezer either (i) by a direct contact, (ii) via a heat conveying member, or (iii) via either one of the following: liquid nitrogen, liquid helium, gas nitrogen, and gas helium.

6. A superconducting permanent magnet apparatus described in Claim 5, wherein, said freezer is an ultra-low temperature freezer (i) of which constitution is a GM type, a pulse tube type, a Stirling type, a Solvay type, or a combination of a plurality thereof, (ii) which cools and maintains said composite bulk within a temperature range between 4K and 90K in absolute temperature, and (iii) are located at such a separated position from said composite bulk that ferromagnetic members constituting said freezer can function well without being hindered by said magnetic field for magnetizing said bulk superconductors.

7. A superconducting permanent magnet apparatus described either in any of Claims 1–3, wherein, said cooling apparatus is constituted such that (i) said composite bulk is

connected with a cooling part of a freezer via a heat conveying member which is provided in said vacuum vessel, thus (ii) said composite bulk is cooled, in a condition that thermal conduction from the outside is prevented.

8. A superconducting permanent magnet apparatus described either in Claim 1, or in Claim 2, wherein, each of a plurality of said bulk superconductors, further, (a) is fit with a ring that is made of one or a plurality of the following materials: stainless steel, aluminum or its alloy, copper or its alloy, synthetic resin, and fiber-reinforced resin, and (b) is placed in tight contact with said ring by using one or a plurality of the following materials: an adhesive or a resin-based filler, a grain- (or, particle-) dispersion type resin, and a fiber-reinforced resin, (i) in order to reinforce the circumference of the bulk superconductor, as well as (ii) in order to disperse heat from the bulk superconductor.

9. A superconducting permanent magnet apparatus described either in any of Claims 1–3, wherein, each of a plurality of said bulk superconductors (a) contains (i), as a main component, a compound with a chemical expression REBa2Cu3Oy, wherein RE comprises one or a plurality of the following elements: yttrium, samarium, neodymium, europium, erbium, ytterbium, holmium, and gadolinium, (ii), as a second-phase component, 50 mol% or less of a compound with a chemical expression RE2BaCuO5, (iii) 30 weight% or less of silver, and (iv), as an additive , 0 to 10 weight% or less of platinum or cerium, then, (b) is obtained by growing a large crystal structure, using a seed crystal.

10. A superconducting permanent magnet apparatus described in any of Claims 1–3, wherein, said vacuum vessel is vacuumized to the reduced pressure of 10^{-1} Pa or less, by said vacuumizing apparatus, (i) which is connected with said vacuum vessel, (ii) which is either one, or combination of a plurality, of a diaphragm pipe, an oil rotating pump, a

turbo molecule pump, an oil diffusion pump, a dry pump, and a cryo-pump, thus (iii) which thermally insulates by vacuum from the outside, said composite bulk within said vacuum vessel.